

PSOLUS PAWSONI
(ECHINODERMATA: HOLOTHUROIDEA),
A NEW BATHYAL SEA CUCUMBER
FROM THE FLORIDA EAST COAST

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Abstract.—*Psolus pawsoni*, new species, is described and illustrated from material collected off northeast Florida at a depth of 322 m. A key to the 11 species of *Psolus* known to occur in the western Atlantic is given.

The holothurian genus *Psolus* Oken, 1815, comprises approximately 30 species distributed from the tropics to the polar regions (Deichmann 1941). Within the past two decades, three new psolids (*Lissothuria antilensis* Pawson, 1967; *Psolus megaloplax* Pawson, 1968; *Psolidium prostratum* Pawson and Valentine, 1981) have been described from the western Atlantic. Like many members of the family Psolidae, these three diminutive species lead a sedentary, cryptic existence firmly attached to hard substrata by large podia arising from a flattened ventral sole. Psolids are frequently overlooked because of their small size and their ability to contort their bodies to conform to irregularities of the substratum. Accordingly it was not surprising to discover yet another new psolid affixed to a single rock dredged from a depth of 322 m off Jacksonville, Florida. This new species, *Psolus pawsoni*, shares its closest affinities with two western Atlantic congeners, *P. megaloplax* Pawson, 1968, and *P. valvatus* Östergren, 1904. The type material described here was collected during the SEAMAP program of the Atlantic States Marine Fisheries Commission and has been deposited at the National Museum of Natural History (USNM), the Harbor Branch Foundation, Inc. (IRCZM), and the Florida Department of Natural Resources (FSBC).

Order Dendrochirotida Grube, 1840

Family Psolidae Perrier, 1902

Psolus pawsoni, new species

Figs. 1–3

Diagnosis.—Dorsal plates lacking layer of granules; mouth and anus separated by 3–4 plates; several dorsal plates 2–3 times larger than oral valves; oral radial “teeth” absent; ossicles of sole exclusively knobbed plates with 4–12 perforations; margin of sole with single row of podia; tentacles with perforated plates.

Material examined.—HOLOTYPE: UNSM E33327, 9.9 mm total length (TL), R/V *Chapman*, Cr 85-03, Sta 11, 5 Jun 1985, 30°31.4'N, 79°59.5'W to 30°30.2'N, 79°59.9'W, 322 m, 55' shrimp trawl, clinging to large phosphorite nodule.—PARATYPES: (same locality data as holotype); USNM E33328, 7 specimens, 4.5–10.8 mm TL; IRCZM 71:305, 1 specimen, 9.2 mm TL; FSBC I 31952, 1 specimen, 9.0 mm TL.

Description of holotype.—Small, elliptical, flattened specimen (9.9 mm TL × 6.9 mm W × 1.3 mm H) with dorsal surface slightly convex (Fig. 1A); greatest height determined by distal tips of oral valves. Excepting lateral fringe of 1–2 rows of small plates, dorsal plates large (largest plate 3.6 mm long), scarcely imbricate, with granular

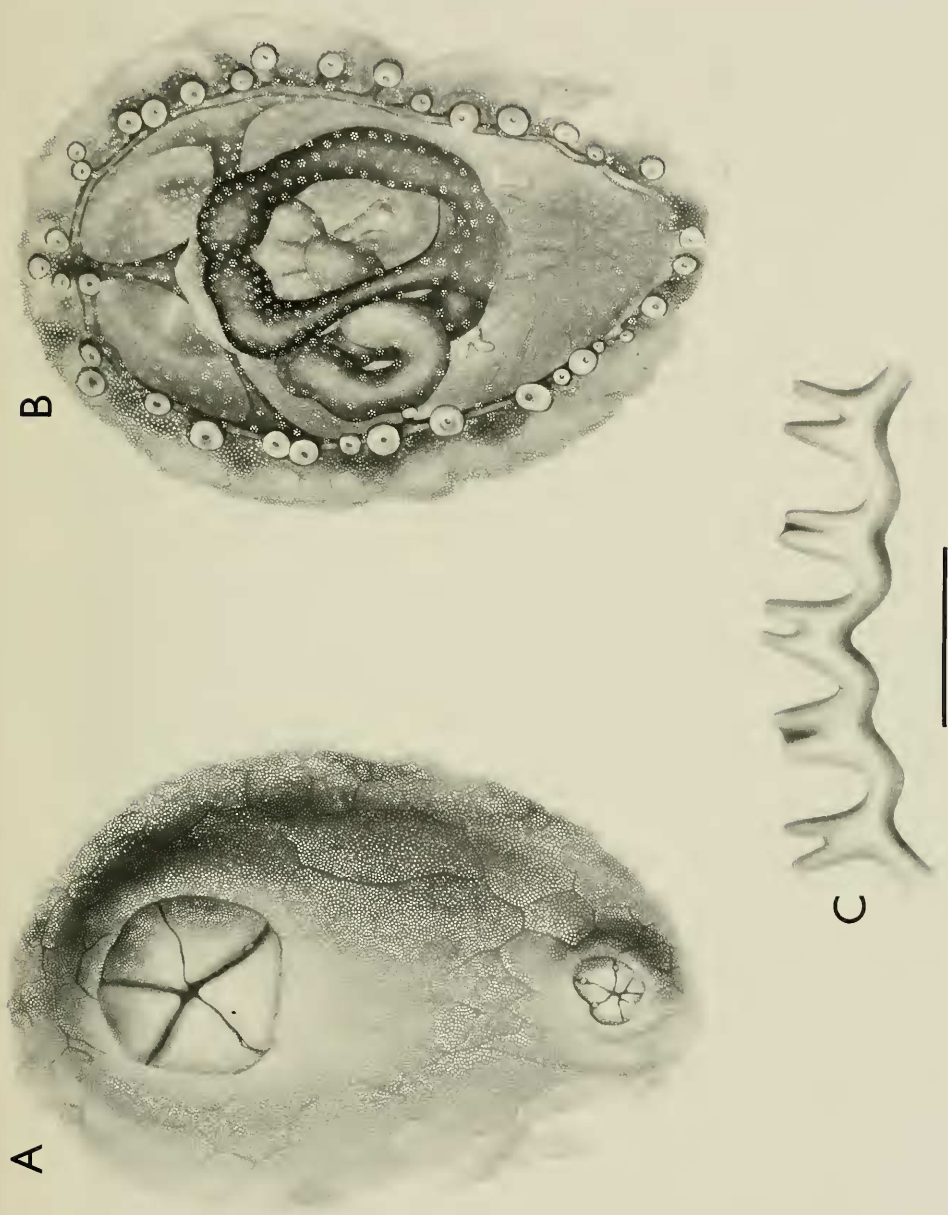


Fig. 1. *Psolus pawsoni*, Holotype, USNM E33327, 9.9 mm TL: A, Dorsal aspect; B, Ventral aspect; C, Three radial and two interradial segments of calcaresous ring from paratype, USNM E33328, 10.8 mm TL. Scale bar = 1.0 mm (C only).

appearance but lacking layer of distinct granules. Several dorsal plates 2–3 times larger than oral valves. Mouth and anus separated by 3 plates. Introvert and all but one tentacle retracted, concealed by 5 large triangular oral valves placed interradially; radial oral “teeth” absent. A small papilla is found at the base of two adjacent oral valves; another is visible deeper in the aperture. Anus surrounded by 5 triangular valves, 2 of which appear to be subdivided. A single small papilla is situated between 4 of the 5 anal valves near the base of the plates.

Ventral surface flattened, covered by thin, fragile, transparent sole, through which internal anatomy visible (Fig. 1B). Margin of sole defined by single row of 36 nearly evenly spaced podia. Midventral radius naked, excepting single podium at anterior end.

Variation in type series.—Smallest specimens (4.5–8.8 mm TL) scale-like, subcircular in outline. On each of two specimens (6.5–8.8 mm TL), 2 podia found on midventral radius near posterior end; another specimen (9.2 mm TL) with 3 podia on posterior end and 1 podium on anterior end of midventral radius. Number of plates between mouth and anus 3 or 4.

Description of internal anatomy.—(Dissection of paratype, 10.7 mm TL): Calcareous ring simple with undulating posterior margin (Fig. 1C). Radial pieces with deep anterior notch for insertion of retractor muscle; interradiial pieces shorter, with shallow anterior groove. Tentacles short (1.3–1.6 mm long), equal, weakly branched. Polian vesicle single, bulbous, arising from water ring in left ventral interradius. Stone canal short (300–400 μ m), embedded in dorsal mesentery and terminating with small, spherical madreporite composed of numerous curved ossicles. Mouth connected to intestine by distinct esophagus. Intestine emptying into large cloaca, supported by complex system of cloacal suspensors occupying posterior third of body cavity. Respiratory trees poorly developed, extending

from cloaca to posteriormost loop of intestinal tract. No gonadal tubules found.

Description of skeletal ossicles.—(Refer to Table 1 for measurements.)

Ventral sole: Ossicles exclusively a single layer of well-spaced, perforated plates with 4–12 perforations. Margin and central network of plates with smooth, rounded knobs on outer surface (Fig. 2A, D–F); knobs few or absent on inner surface of plates (Fig. 2E, G). Incomplete perforations and knobs on margin give plates a spinous appearance. Plates more crowded at anterior and posterior ends of sole.

Tube feet: Straight to curved perforated plates similar to those found in the sole (Fig. 3A–D). Plates in distal portion of podia with fewer knobs. Well-developed end plates 250–300 μ m in diameter (Fig. 3E, F). Largest end plates with secondary network. Diameter of end-plate perforations increasing from center to margin of plate.

Tentacles: Straight to curved, smooth, irregular, perforated plates with undulating margin (Fig. 3G–I); rods absent.

Internal organs: No deposits were found in the intestine, respiratory trees, polian vesicle or cloaca of the dissected paratype.

Coloration and habit.—Color in life very pale, nearly white; alcoholic specimens white. Easily mistaken by the casual observer as juvenile slipper limpets (Crepidulidae), jingle shells (Anomiidae), oysters (Ostreidae), or bleached chitons (Polyplacophora).

Examination of gut contents.—Gut contents were removed from the dissected paratype and examined at 400 $\times$. Although most material found in the intestine was unidentifiable, recognizable food items consisted of diatoms, remains of filamentous algae, and a few foraminiferans and sponge spicules.

Remarks.—In its small size and the shape of skeletal ossicles found in the ventral sole, *P. pawsoni* appears to be most closely related to *P. megaloplax* Pawson, 1968, from

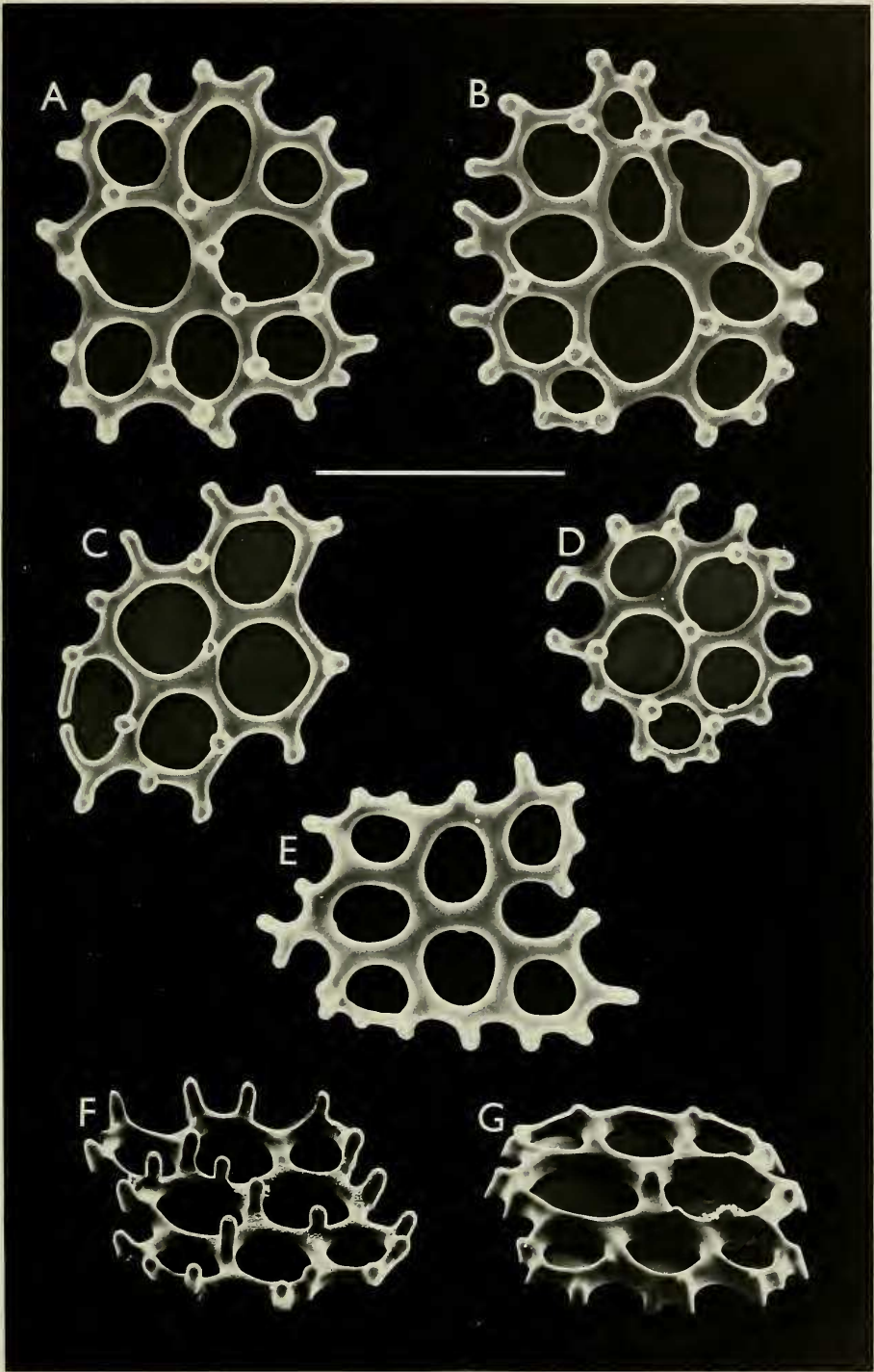


Fig. 2. Scanning electron micrographs of skeletal ossicles from *Psolus pawsoni*: A–G, Plates from sole, showing outer [A–D, F (oblique view)] and inner [E, G (oblique view)] surface of plates. Scale bar = 100 μm .

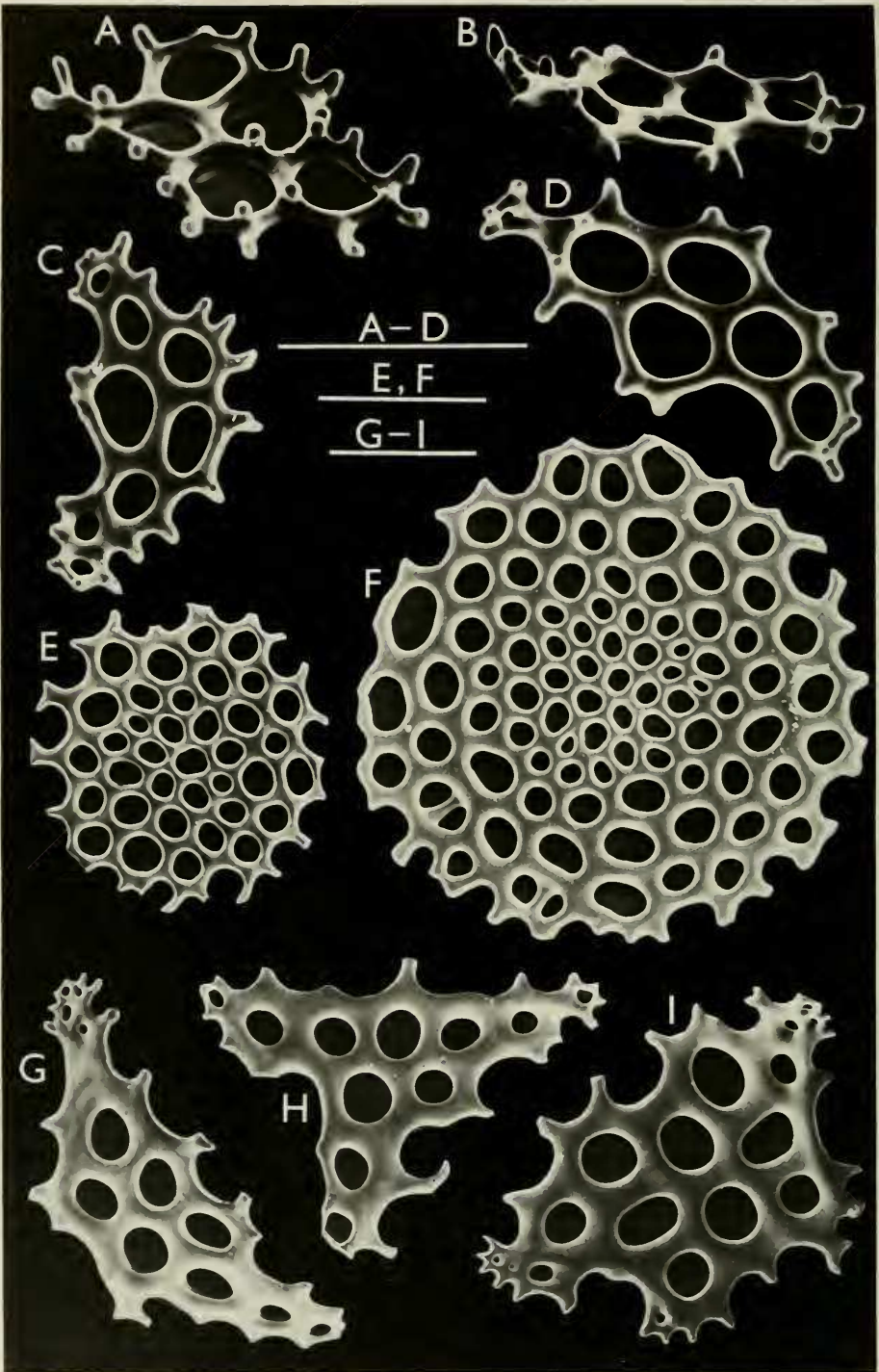


Fig. 3. Scanning electron micrographs of skeletal ossicles from *Psolus pawsoni*: A-D, Plates from podia; E, F, End plates from podia; G-I, Plates from tentacles. Scale bars = 100 μ m.

Table 1.—Dimensions and number of perforations of body wall ossicles in *Psolus pawsoni*. n, number of ossicles (or knobs) examined; $\bar{x}$, mean; SD, standard deviation; ossicles taken from specimens 8.5–10.8 mm TL.

	n	$\bar{x}$	SD	Range
Plates of sole:				
Length (μ m)	60	124	13	93–159
Width (μ m)	60	105	15	49–150
Height of knobs (μ m)	19	9.3	1.4	7.6–12.6
Width of knobs (μ m)	19	5.8	0.5	5.1–6.8
No. of perforations	60	7.5	1.8	4–12
Plates of tube feet:				
Length (μ m)	30	139	21	102–203
Width (μ m)	30	85	19	59–132
No. of perforations	30	8.1	2.5	4–12
Plates of tentacles:				
Length (μ m)	30	179	57	93–282
Width (μ m)	30	120	28	75–190
No. of perforations	30	11.8	2.9	7–20

St. Croix, Virgin Islands, and *P. valvatus* Östergren, 1904, occurring off Norway, Ireland, Iceland, Greenland, and New England. None of these species is known to exceed 21 mm TL, and all have similarly shaped knobbed plates in the sole, although the number of perforations differs. Table 2 compares these three congeners.

It is notable that a juvenile specimen of *Psolus tuberculosus tuberculosus* Deichmann, 1930 (IRCZM 71:306) was removed from the same rock on which the type series of *P. pawsoni* was found. The single specimen measures 7 mm TL and is quite distinguishable from *P. pawsoni*, even at this small size, by four features: presence of radial oral “teeth”; tuberculation on dorsal plates; radially arranged accessory plates externally at base of oral valves; outer row of reduced podia perforating marginal plates.

Etymology.—The species is named for David L. Pawson, Smithsonian Institution, in recognition of his contributions to holothurian systematics.

Distribution.—Currently known only from the type locality.

Table 2.—Comparison of *Psolus pawsoni*, n. sp., *P. megaloplax* Pawson, and *P. valvatus* Östergren. Comparisons based on examination of following specimens and publications: *P. pawsoni* [type series]; *P. megaloplax* [type series, Universitetets Zoologiske Museum, Copenhagen; original description, Pawson (1968)]; *P. valvatus* [Museum of Comparative Zoology MCZ 1452, 1 specimen, 12 mm TL; Mortensen (1927); Deichmann (1930)]; +, present; –, absent.

	<i>P. pawsoni</i>	<i>P. megaloplax</i>	<i>P. valvatus</i>
Number of plates separating mouth and anus	3–4	2	5–10*
Several dorsal plates 2–3 times larger than oral valves	+	+	–
Layer of granules covering dorsal plates	–	+	–
Marginal fringe of small plates	+	–	+
Average number of perforations in ossicles of sole	7–8	4	4
A cycle of radial “teeth” present below oral interradial valves	–	+	–
Outer row of reduced marginal podia	–	+	+

* Mortensen (1927) and Deichmann (1930) state that *P. valvatus* has about 5 dorsal plates between the mouth and anus. Our examination of MCZ 1452 (identified by Deichmann) revealed that there are 10 plates separating the mouth and anus in this specimen.

Key to Species of the Genus *Psolus* from the Western Atlantic Ocean

1. Oral aperture surrounded by 5 large interradial valves 2
- Oral aperture surrounded by many small plates, although the plates in some species may occur in cycles of about 5 plates each 10
2. Baskets embedded in sole 3
- No baskets in sole 4
3. Dorsal plates with numerous spiniform granules; 2 dorsal plates between oral and anal valves [Brazil, 50–100 m]
..... *P. vitoriae* Tommasi, 1971

- Dorsal plates naked; 4 dorsal plates between oral and anal valves [Brazil, 95 m] *P. marcusii* Tommasi, 1971
- 4. Oral aperture with 5 narrow radial “teeth” within interradi al valves 5
- Radial oral “teeth” absent 9
- 5. Dorsal integument with baskets [Barbados, 250 m] *P. complicatus* Deichmann, 1930
- Dorsal integument without baskets 6
- 6. Dorsal plates tuberculated; plates in sole with dozens of perforations 7
- Dorsal plates not tuberculated; plates in sole with about 4 perforations 8
- 7. Oral aperture with 5 radial accessory plates externally at base of oral valves [Gulf of Mexico to South Carolina, 73–185 m] *P. tuberculosus tuberculosus* Théel, 1886
- Radial accessory oral plates absent [Barbados, Dominica, 133–229 m] *P. tuberculosus destituta* Deichmann, 1930¹
- 8. Oral aperture with 5–12 radial accessory oral plates externally at base of oral valves; anal valves absent; dorsal plates imbricate, 3–10 between oral valves and anal aperture [Sand Key and Key West (Florida), Barbados, 147–250 m] *P. operculatus* (Pourtales, 1868)
- Radial accessory oral plates absent; anal valves present; dorsal plates tessellated, 2–3 between oral and anal valves [St. Croix, 90–360 m] *P. megaloplax* Pawson, 1968
- 9. About 5 dorsal plates between oral and anal valves; plates in sole with 4–5 perforations; two rows of podia on margin of sole, outer podia reduced [Norway to New England, 20–500 m] *P. valvatus* Östergren, 1904
- Three to 4 dorsal plates between oral and anal valves; plates in sole with 5–12 perforations; single row of podia along margin of sole [Atlantic coast of Florida, 322 m] .. *P. pawsoni*, n. sp.
- 10. Dorsal plates lacking granules; ossicles of sole smooth plates with 4 perforations or cruciform bodies [Scotland to Gulf of Maine, 1096–2091 m] ... *P. pourtalesi* Théel, 1886
- Dorsal plates covered with granules; ossicles of sole consisting of baskets or complex oval/spherical bodies 11
- 11. Posterior end tail-like; anal aperture surrounded by many cycles of plates; sole comparatively small, rectangular; midventral ambulacrum complete [Norway to New England, 0–400 m] *P. phantapus* (Strussenfeldt, 1765)
- Tail absent; few periproctal cycles of plates; sole large, oval; midventral ambulacrum incomplete [Norway to New England, 0–1800+ m] .. *P. fabricii* (Düben and Koren, 1846)

¹ We have examined the type material (MCZ 338) of *Psolus tuberculosus* var. *destituta* Deichmann, 1930. Based on available morphological and geographic information, we believe the material represents a valid subspecies. There is no reason to suspect that Deichmann used “variety” as an infrasubspecific rank in this case, and thus we regard the name to be available [ICZN Art. 12a, 16, 45f and g(ii)]. We assume [Art. 31b(i)] that Deichmann wrote *destituta* as a noun in apposition, derived from the Latin *destituere*, to abandon, in reference to the lack of accessory oral plates.

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Literature Cited

- Deichmann, E. 1930. The holothurians of the western part of the Atlantic Ocean.—*Bulletin of the Museum of Comparative Zoology* 71(3):41–226, 24 pls.
- . 1941. The holothurians collected by the Velerio III during the years 1932 to 1938. Part I, Dendrochirota.—*Allan Hancock Pacific Expeditions* 8(3):61–194, pls. 10–30.
- Düben, M. W., and J. Koren. 1846. Ofversigt af Skandinaviens Echinoderm.—*Kungliga Svenska Vetenskaps-Akademiens Handlingar*, for År 1844:229–328, pls. 6–11.
- Mortensen, T. 1927. *Handbook of the echinoderms of the British Isles*. 471 pp., 269 figs. Oxford University Press.
- Östergren, H. 1904. Eine neue *Psolus*-Art, *Ps. valvatus*.—*Zoologische Anzeiger* 27:659–662.
- Pawson, D. L. 1967. The psolid holothurian genus *Lissothuria*.—*Proceedings of the United States National Museum* 122(3592):1–17, 5 figs.
- . 1968. A new psolid sea cucumber from the Virgin Islands.—*Proceedings of the Biological Society of Washington* 81:347–350, 1 fig.
- , and J. F. Valentine. 1981. *Psolidium prostratum*, new species, from off the east coast of the U.S.A. (Echinodermata: Holothuroidea).—*Proceedings of the Biological Society of Washington* 94(2):450–454, 2 figs.
- Pourtalès, L. F. de. 1868. Contribution to the fauna of the Gulf Stream at great depths.—*Bulletin of the Museum of Comparative Zoology* 1(7):121–142.
- Strussenfeldt, A. M. von. 1765. Beskrifning på et Syokrak, Hafs-Spoke kalladt.—*Kungliga Svenska Vetenskaps-Akademiens Handlingar* 26:256–266, pl. 10.
- Théel, H. 1886. Report on the Holothurioidea. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877–78), in the Caribbean Sea (1879–80), and along the eastern coast of the United States during the summer of 1880, by the U.S. Coast Survey Steamer “Blake.”—*Bulletin of the Museum of Comparative Zoology* 13(1):1–21, 1 pl.
- Tommasi, L. R. 1971. Equinodermes do Brasil. I. Sobre algumas espécies novas e outras pouco conhecidas, para o Brasil.—*Boletim do Instituto Oceanográfico de São Paulo* 20:1–21, 23 figs.

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Note added in proof:

We thank Patricia A. Lindsay and John B. Wise, South Carolina Department of Wildlife and Marine Resources, for bringing to our attention 4 more specimens of *Psolus pawsoni*: IRCZM 71:341, 7–11 mm TL, R/V LADY LISA, Golden Crab Project, Year II, 19 May 1986, vicinity of 31°21'N, 79°34'W (east of Brunswick, Georgia), ≈450 m, rocket grab, clinging to rock. A specimen of *P. operculatus* (IRCZM 71:342) from the same rock represents a considerable range extension for this species.